United States Environmental Protection Agency
Region 10
1200 Sixth Avenue
Seattle, Washington 98101

Statement of Basis

A Draft National Pollutant Discharge Elimination System (NPDES) Permit has been prepared to address withdrawn portions.

NPDES Permit: AK-003865-2

Applicant: Teck Alaska, Inc.
Red Dog Operations
3105 Lakeshore Dr. Bldg A Suite 101
Anchorage, AK 99507

Facility Contact: Robert Napier (907) 426-9145
Facility Location: Foothills of the DeLong Mountains near Kotzebue, Alaska

Receiving Water: Middle Fork Red Dog Creek

I. PROPOSED ACTION, TYPE OF FACILITY AND DISCHARGE LOCATION:

Pursuant to 40 CFR 124.19(d), Region 10 of the United States Environmental Protection Agency is proposing to reissue certain portions of National Pollutant Discharge Elimination System Permit No. AK-003865-2, which the Region issued to Teck Alaska Incorporated on January 8, 2010 ("2010 Permit"). EPA is proposing this action to address five effluent limitations that EPA withdrew from the 2010 Permit on March 17, 2010.

The Red Dog zinc/lead mine is located in the Northwest Arctic Borough of Alaska, 90 miles north of Kotzebue and 47 miles inland from the coast of the Chukchi Sea. The mine site is located on a ridge between the Middle and South Forks of Red Dog Creek, in the DeLong Mountains of the Western Brooks Range. The ore body lies within the drainage basin of the Middle Fork of Red Dog Creek. The open pit mine is established on both sides of the valley of the Middle Fork of Red Dog Creek. Facilities at the mine site include an open pit zinc/lead mine, concentrator, tailings impoundment, concentrate storage building, maintenance facilities, power generation plant and an accommodations complex. Red Dog Mine discharges to the Middle Fork Red Dog Creek through Outfall 001, which is the discharge point for treated mine drainage and excess precipitation. Outfall 001 is located at latitude 68º 04' 17" N, and longitude 162º 52' 05" W. Detailed descriptions of the mine and the history of Permit No. AK-003865-2 are included in the Fact Sheet that accompanied the draft of the 2010 Permit. The Fact Sheet is available at http://www.epa.gov/region10/pdf/permits/npdes/ak/ak0038652-fs-1208.pdf.

II. LIMITATIONS AND CONDITIONS

As described below, EPA is proposing to retain or change five effluent limitations found in Part I.A.1. of the 2010 Permit. All other conditions of the 2010 permit, including effluent limitations and monitoring provisions, became fully effective and enforceable on March 31,

2010, and remain effective and unchanged. For clarity, rather than issue only the revised permit provisions, the proposed draft permit includes the entire text of the permit. **However, EPA is requesting comment only on the five effluent limitations proposed in this action. Comments on any other permit conditions will not be considered.**

III. BACKGROUND FOR THIS ACTION

On January 8, 2010, Region 10 reissued the NPDES Permit for the Red Dog Mine. On February 16, 2010, Trustees for Alaska and the Center on Race, Poverty and the Environment, representing regional environmental groups, local individuals and the Native Villages of Kivalina and Point Hope, filed a petition for review of the permit with EPA's Environmental Appeals Board (EAB). Among other things, the petition raised issues regarding antidegradation implementation procedures in the State of Alaska. By letter dated February 26, 2010, Region 10 identified five contested permit conditions that were stayed by the petition for review – effluent limits for lead (monthly average limit), selenium (daily maximum limit), zinc, weak acid dissociable (WAD) cyanide, and total dissolved solids. All remaining, uncontested permit conditions became fully effective and enforceable on March 31, 2010, in accordance with 40 CFR 124.16(a)(2) and 124.20(d). On March 17, 2010, EPA withdrew the five contested effluent limits and on April 30, 2010, the EAB dismissed as moot those portions of the petition for review related to the withdrawn limits.

On July 14, 2010, the State of Alaska's Department of Environmental Conservation issued a policy and procedure document setting forth *Interim Antidegradation Implementation Methods.*

On November 8, 2010, the EAB denied review of the remaining issue in the petition related to monitoring requirements. On December 8, 2010, Region 10 issued a final permit decision notifying the parties that, with the exception of the withdrawn limits identified above, all conditions in the 2010 Permit remained in effect. In addition, Region 10 stated that the following conditions in the 1998 NPDES Permit No. AK-003865-2 would remain in effect until further agency action:

- Part I.A.1 - effluent limitations for lead (monthly average limit), selenium (daily maximum limit), zinc, total dissolved solids, and total cyanide

EPA now proposes this action pursuant to 40 CFR 124.19(d) to address the five withdrawn limits. As described in detail below, EPA is proposing effluent limitations for the following parameters: lead (monthly average limit), selenium (daily maximum limit), zinc, total dissolved solids, and WAD cyanide.

IV. BASIS FOR PROPOSED EFFLUENT LIMITATIONS

Lead, Selenium and Zinc

Section 301(b) of the Clean Water Act requires technology-based controls on effluents. EPA's effluent limitation guidelines (ELGs) for the mining industry at 40 CFR Part 440, Subpart J, provide technology-based effluent limitations for lead and zinc, among others. Within this ELG, the New Source Performance Standards at 40 CFR 440.104 apply to Red Dog Mine. Table 1 shows the technology-based limitations:

Table 1 Technology-based Limitations		
Parameter[1]	Maximum Daily	Average Monthly
Lead[2]	600	300
Selenium[3]	-	-
Zinc[2]	1500	750

1 - Units are ug/L unless otherwise noted.
2 - Hardness based metals criteria used a hardness of 260 mg/L $CaCO_3$
3 - The ELG development document considered selenium and determined that it was found at levels too low to be effectively treated but that a surrogate relationship exists between selenium and total suspended solids. *Development Document for Effluent Limitations Guidelines and Standards for the Ore Mining and Dressing Point Source Category*, EPA 440/1-82/061, at pp. 197-98, 202.

EPA then determines the Water Quality-based effluent limitations (WQBELs). By letter dated September 8, 2010, Teck requested that EPA replace the withdrawn monthly average limitations for lead and zinc as well as the daily maximum limitations for selenium and zinc with the 1998 Permit limitations, which currently remain in effect. The 1998 Permit limitations for these parameters are more stringent than those calculated for the 2010 Permit and are more stringent than necessary to protect the receiving water. Based on Teck's request, EPA is proposing to reissue the 1998 Permit limitations for these specific parameters. Table 2 shows the comparison between the 1998 and 2010 Permit limitations, along with the limits proposed in this action.

Table 2 WQBELs Comparison						
Parameter[1]	1998 Permit		2010 Permit		2011 Proposed WQBELs	
	Maximum Daily	Average Monthly	Maximum Daily	Average Monthly	Maximum Daily	Average Monthly
Lead[2]	19.6	8.1	18.3	8.5	18.3	8.1
Selenium	5.6	4.9	7.2	4.4	5.6	4.4
Zinc[2]	257.3	119.6	269.2	155.9	257.3	119.6

1 - Units are ug/L unless otherwise noted.
2 - Hardness based metals criteria used a hardness of 260 mg/L $CaCO_3$

Table 3 shows a comparison between technology-based limits from the ELGs and the WQBELs proposed above. NPDES permits must include WQBELs if the technology-based ELGs are not sufficient to achieve water quality standards, 40 CFR 122.44(d). Based on this comparison, the draft permit limits appear in the far right column below.

Table 3 Draft Permit Effluent Limitations						
Parameter[1]	Technology-based		WQ-based		Draft Permit Limits	
	Maximum Daily	Average Monthly	Maximum Daily	Average Monthly	Maximum Daily	Average Monthly
Lead[2]	600	300	18.3	8.1	18.3	8.1
Selenium[3]	-	-	5.6	4.4	5.6	4.4
Zinc[2]	1500	750	257.3	119.6	257.3	119.6

1 - Units are ug/L unless otherwise noted.
2 - Hardness based metals criteria used a hardness of 260 mg/L $CaCO_3$
3 - The ELG development document considered selenium and determined that it was found at levels too low to be effectively treated but that a surrogate relationship exists between selenium and total suspended solids. *Development Document for Effluent Limitations Guidelines and Standards for the Ore Mining and Dressing Point Source Category*, EPA 440/1-82/061, at pp. 197-98, 202.

Total Dissolved Solids (TDS)

Because TDS was not considered in development of the ELGs, a case-by-case technology-based effluent limitation has been evaluated in Appendix A, in accordance with 40 CFR 125.3(c). As detailed in Appendix A, based on existing information, the technology-based effluent limitation for TDS was determined to be 4925 mg/l, measured at the discharge location, Outfall 001.

For water quality-based requirements, ADEC has adopted and EPA has approved a site-specific criterion (SSC) for TDS that would result in effluent limitations only applicable to main stem Red Dog Creek different from those otherwise required under the state-wide water quality standard for TDS. According to the SSC, effluent may be discharged so as to restrict in-stream TDS concentrations to no more than 1500 mg/L at the edge of the mixing zone in Main Stem Red Dog Creek (Station 151). The SSC is a promulgated standard under the Alaska Water Quality Standards and was approved by EPA on April 21, 2006, for this waterbody. The mixing zone is described in the draft § 401 Certification found in Appendix B. The discharge may start after the free flow of water in the Main Stem Red Dog Creek begins.

The 1998 Permit limited TDS in the mine's discharges to 170 mg/l (monthly average) and 196 mg/l (daily maximum). The proposed TDS limit of 1500 mg/l at the edge of the mixing zone is less stringent that the 1998 limit. Clean Water Act Section 402(o)(1) allows for "backsliding" from water-quality based effluent limitations if the requirements of CWA § 303(d)(4) are met. Under CWA § 303(d)(4)(B), which applies to attainment waters, water-quality based effluent limitations may be relaxed provided doing so is consistent with the State's antidegradation policy. The State's draft CWA § 401 Certification includes an analysis based on the requirements of 18 AAC 70.015 and 40 CFR 131.12, which determined that changes to TDS effluent limitations are consistent with Alaska's antidegradation policy and will protect applicable state water quality standards.

EPA has determined that the water quality-based requirements are more stringent than the technology-based requirements (see Appendix A). EPA is therefore proposing the following TDS limitation, which is the same as that withdrawn from the 2010 Permit:

> The permittee shall limit the TDS load discharged from Outfall 001 so as to maintain in-stream TDS concentrations at or below all of the following:
>
> (1) At the edge of the mixing zone (Station 151) in Main Stem Red Dog Creek: 1500 mg/L throughout the discharge season,

Cyanide

Cyanide was considered in the development of the ELG but not included because a quantifiable reduction could not be documented with any technology known to the Administrator. *Development Document,* EPA 440/1-82/061, at p. 203. As such, technology-based limitations are not included for comparison.

The WQS contains criteria for free cyanide. Free Cyanide was previously measured as total cyanide but is now measured as weak acid dissociable (WAD) cyanide. For water quality-based requirements, EPA first determines the water quality criteria to be applied to this discharge and chooses the most stringent.

Table 4 WQ Criterion for Free Cyanide (measured as WAD Cyanide)			
Acute*	Chronic*	Drinking Water	Human Health
22	5.2	200	700
* Aquatic Life Criteria			

A reasonable potential analysis was performed to determine the need for limits. This analysis compares the maximum projected effluent concentration (C_e) to the wasteload allocation for that pollutant. If the projected effluent concentration exceeds the most stringent criterion, there is "reasonable potential" (RP) and a limit must be included in the permit. EPA uses the recommendations in Chapter 3 of the TSD to conduct this analysis.

Since ADEC has proposed a mixing zone for cyanide with a dilution multiplier of 2.5 (See Appendix B), EPA multiplied the criterion by 2.5 to determine the wasteload allocation. This value assures that the criterion would be met at the edge of the mixing zone. EPA then compares this goal to the maximum projected effluent value, which is calculated by multiplying the maximum effluent value by the reasonable potential multiplier. Since 14.9 is greater than the wasteload allocation of 13.0, there is reasonable potential for the effluent to exceed the applicable water quality criteria, and limits are therefore necessary.

Table 5 Reasonable Potential Determination						
	Maximum Effluent Concentration	CV[1]	N= # of Samples	RPM	Maximum Projected Effluent Concentration	Reasonable Potential
Cyanide	12.4 ug/L	0.70	205	1.2	14.9 ug/L	Yes
1 – CV is defined as the Standard Deviation ÷ the Mean of a data set.						

The proposed draft limits for cyanide are based on the more stringent chronic criterion with the proposed mixing zone included. This results in a monthly average and daily maximum limits of 10.3 ug/L and 22.2 ug/L which are less stringent than the 1998 Permit limits of 4.0 ug/L and 9.0 ug/L.

Table 6 Draft Permit Effluent Limitations						
Parameter	Technology-based		WQ-based		Draft Permit Limits	
	Maximum Daily	Average Monthly	Maximum Daily	Average Monthly	Maximum Daily	Average Monthly
WAD Cyanide, ug/L	-	-	22.2	10.3	22.2	10.3

The State's draft CWA § 401 Certification includes an analysis based on the requirements of 18 AAC 70.015 and 40 CFR 131.12, which determined that the cyanide mixing zone and changes to cyanide effluent limitations are consistent with Alaska's antidegradation policy and will protect applicable state water quality standards. As discussed above, the permit may therefore allow backsliding based on Clean Water Act §§ 402(o)(1) and 303(d)(4)(B).

V. PUBLIC COMMENT PERIOD AND PROCEDURE FOR FINAL DECISION

EPA will consider comments only on the effluent limitations proposed in this Statement of Basis.

Persons wishing to comment on, or request a public hearing for, the draft permit action may do so in writing by the expiration date of the public notice period. A request for a public hearing must state the nature of the issues to be raised as well as the requester's name, address, and telephone number. All comments should include name, address, phone number, a concise statement of the basis for a comment and relevant facts upon which it is based. All written comments should be addressed to the Office of Water & Watersheds Director at U.S. EPA, Region 10, 1200 Sixth Avenue Suite 900, OWW-130, Seattle, WA 98101; submitted by facsimile to (206) 553-0165; or comments on the draft permit may be submitted via e-mail to godsey.cindi@epa.gov

After the Public Notice expires and all substantive comments have been considered, EPA's Regional Director for the Office of Water & Watersheds will make a final decision regarding the proposed effluent limitations. If no comments requesting a change in these limitations are received, the proposed limitations will be made final, and will become effective upon final issuance. If comments are received, EPA will address the comments and issue the limitations along with a response to comments. The limitations will become effective 30 days after the issuance date, unless they are appealed to EPA's Environmental Appeals Board within 30 days.

Persons wishing to comment on the State Certification should submit written comments by the public notice expiration date to the Alaska Department of Environmental Conservation c/o Tim Pilon, 610 University Avenue, Fairbanks, Alaska 99709 or Tim.Pilon@alaska.gov.

Documents are Available for Review.

The draft NPDES permit and related documents can be reviewed or obtained by visiting or contacting EPA's Regional Office in Seattle between 8:30 a.m. and 4:00 p.m., Monday through Friday.

United States Environmental Protection Agency
Region 10
1200 Sixth Avenue, Suite 900 OWW-130
Seattle, Washington 98101
(206) 553-0523 or
1-800-424-4372 (within Alaska, Idaho, Oregon and Washington)

The draft permit, this Statement of Basis, and other information can also be found by visiting the Region 10 website at www.epa.gov/r10earth/water.htm. The draft Administrative Record for this action contains the pertinent documents from the 2010 permit and any documents listed in the References section that were not included in the previous Administrative Record. The Administrative Record or documents from it are available upon request by contacting Cindi Godsey.

The draft permit and Statement of Basis are also available at:

EPA Alaska Operations Office
222 W. 7th Avenue Room 537
Anchorage, Alaska 99513-7588
(800) 781-0983 toll free in Alaska only

ADEC
610 University Avenue
Fairbanks, Alaska 99709

For technical questions regarding the Statement of Basis, contact Cindi Godsey at (907) 271-6561 or godsey.cindi@epa.gov. Services can be made available to persons with disabilities by contacting Audrey Washington at (206) 553-0523.

VI. REFERENCES

EPA 1982. Development Document for Effluent Limitations Guidelines and Standards for the Ore Mining and Dressing Point Source Category Office of Water, Washington, DC. November 1982. EPA 440/1-82/061.

http://www.safewater.org (2011). Ultrafiltration, Nanofiltration and Reverse Osmosis. Retrieved March 21, 2011, from http://www.safewater.org/PDFS/resourcesknowthefacts/Ultrafiltration_Nano_ReverseOsm.pdf

Red Dog Mine Extension Aqqaluk Project Supplemental Environmental Impact Statement. January 2010.

EPA 1991. *Technical Support Document for Water Quality-based Toxics Control*. Office of Water Enforcement and Permits, Office of Water Regulations and Standards. Washington, DC. March 1991. EPA/505/2-90-001.

EPA 2010. *NPDES Permit Writers' Manual 2010.* Office of Wastewater Management, Water Permits Division, State and Regional Branch. Washington, DC. September 2010. EPA-833-K-10-001.

http://www.epa.gov (2011). Water Health Series: Filtration Facts. Retrieved March 21, 2011, from http://www.epa.gov/safewater/faq/pdfs/fs_healthseries_filtration.pdf.

Memorandum dated February 11, 2011, from Chris Eckert and Robert Napier, Teck Alaska Incorporated, to Cindi Godsey, EPA, regarding information related to the use of the barium hydroxide water treatment process at Red Dog Mine.

Memorandum dated February 21, 2008, from Frank Johns and Ron Rimelman, TetraTech (EPA's 3rd party SEIS contractor), to Gene Weglinski, TetraTech regarding Water Treatment Alternatives for Red Dog Mine.

E-mail dated February 16, 2011, from Gene Weglinski, TetraTech, to Cindi Godsey, EPA, regarding cost of reverse osmosis treatment described in the SEIS.

Appendix A
Technology-based Best Professional Judgment Analysis

REGULATORY REQUIREMENT

Federal regulations at 40 CFR 125.3(c)(3) require EPA to develop technology-based effluent limitations on a Best Professional Judgment (BPJ) case-by-case basis for each aspect or activity not subject to an effluent limitation guideline. An *effluent limitation* is defined in 40 CFR 122.2 as "any restriction imposed by the Director on quantities, discharge rates, and concentrations of 'pollutants' which are 'discharged' from 'point sources' into 'waters of the United States'. . ." A technology-based treatment requirement represents "the minimum level of control that must be imposed in a permit issued under section 402 of the [Clean Water] Act." 40 CFR 125.3(a).

The Effluent Limitation Guideline (ELG) for Ore Mining and Dressing, Subpart J - Copper, Lead, Zinc, Gold, Silver, and Molybdenum Ores Subcategory (40 CFR Part 440, Subpart J) applies to the discharge from the Red Dog Mine. The ELG, however, does not limit total dissolved solids (TDS), nor was TDS a pollutant considered during development of the ELG. Because TDS is present in the discharge from the Red Dog Mine, EPA is developing a BPJ case-by-case effluent limitation for TDS based on the information that follows.

For non-toxic, non-conventional pollutants such as TDS, technology-based effluent limitation must be established based on the best available technology economically achievable (BAT). 40 CFR 125.3(a)(2)(v). In addition, 40 CFR 125.3(d)(3) lists the factors for consideration in developing a BAT effluent limitation. These factors are (i) the age of equipment and facilities involved; (ii) the process employed; (iii) the engineering aspects of the application of various types of control techniques; (iv) process changes; (v) the cost of achieving such effluent reduction; and (vi) non-water quality environmental impact (including energy requirements).

The BPJ analysis that follows addresses these regulatory factors.

A range of wastewater treatment options for TDS were considered for inclusion in this BPJ analysis including the current treatment technology used at the Red Dog Mine, several membrane processes, treatment with barium hydroxide, ion exchange, and biological treatment. Much of the information on the treatment technologies is based on the evaluation in the Red Dog Mine Extension Aqqaluk Project Supplemental Environmental Impact Statement (SEIS).

Current Wastewater Treatment Process

Tailings pond water (reclaim water) is pumped to Water Treatment Plant 2 (WTP-2) near the mill, which is seasonally operated and treats reclaim water for discharge through Outfall 001. While parts of WTP-2 are older, the present configuration of treatment has been operating at least since the 1998 Permit was issued. Within the WTP-2 supply pipeline, reclaim water is first treated in the pipeline with sodium sulfide and mixed via an in-line mixer. The sulfide reacts with the dissolved cadmium and other metals in the reclaim water to form insoluble cadmium sulfide and other metal sulfides, which are stable throughout the remainder of the treatment process. The sodium sulfide-treated reclaim water then proceeds to a rapid mix tank where lime (calcium hydroxide) and recycled clarifier underflow solids are added to adjust the pH. From the rapid mix tank: the solution flows into the lime reactor which provides residence time for complete chemical reactions to occur. Additionally, compressed air is added into the lime reactor tank to ensure full oxidation of all ions in solution, specifically and most significantly the oxidation of metals.

The precipitated solids containing the metals are maintained in suspension and flocculent is added to unite smaller particles into larger solids in the flocculent mix tank. The solution then flows into a clarifier where the solids are allowed to gravity-settle. Settled solids are removed through the "underflow" and the treated decant water leaves the clarifier through the "overflow". Underflow solids are recycled back to the beginning of the treatment process with some solids periodically purged from the system to the tailings impoundment to maintain a constant sludge bed level in the clarifier.

Clarifier overflow water proceeds to four sand filters operated in a parallel configuration. The sand filters remove any residual solids not settled out of solution within the clarifier. Automated pH and turbidity meters take final measurements of the sand filter effluent. If the pH is within NPDES permit limits and within the operating range established to ensure effective treatment and the turbidity is within an established range which indicates that effective solids removal has been accomplished, the water is discharged to Red Dog Creek. If the pH and turbidity are not within the prescribed range, the filtered water is discharged back into the tailings impoundment.

Currently, Teck is focused on using source control techniques to reduce the TDS levels in the tailings impoundment. WTP-3 was constructed during the winter/spring of 2004/2005 and began operating in 2006. The plant treats seepage and runoff from the Main Waste Stockpile and Mine Sump (both of which have high TDS concentrations) before it enters the tailings impoundment. Like WTP-2, WTP-3 uses a lime precipitation process for metals removal.

Membrane Processes

Reverse osmosis units force water through a semi-permeable membrane under pressure, leaving contaminants behind. Reverse osmosis units treat approximately three times more water than they discharge. Reverse osmosis removes turbidity, microbes, and virtually all dissolved substances. However, while reverse osmosis removes many harmful minerals, such as salt and lead, it also removes some healthy minerals, such as calcium and magnesium.

The pressure utilized during reverse osmosis depends on the TDS concentration and must be greater than the osmotic pressure for the solution. Typical pressures for reverse osmosis applications range from 300 to 1,200 pounds per square inch to create a flow of clean water from low TDS concentration to high TDS concentration through the membrane. The current high TDS concentrations in the tailings reclaim water (>4,000 mg/L), would reduce the effectiveness of a reverse osmosis system. As noted above, the mine has been disposing of sludge generated from WTP-2 in the tailings impoundment since the start of treatment operations, contributing to gypsum levels near saturation in the pond water. Using gypsum saturation as the design point for the reverse osmosis process, the maximum recovery of clean water would likely be in the range of 30 to 50 percent. Therefore, to discharge 15 million gallons per day (MGD) of treated water during the discharge season, 30 to 50 MGD would need to be processed. This would result in a brine wastestream of 15 to 35 MGD. With the reverse osmosis influent at the gypsum saturation concentration, the membranes are highly likely to foul or clog, resulting in unreliable performance.

To permanently reduce TDS levels in the impoundment, the brine wastestream cannot be disposed of in the tailings impoundment. Disposal of brine in the waste rock dump and Main Pit would present similar challenges because the brine (and its contained metals) could be resolublized into the water draining from these disposal facilities, which is pumped to the tailings impoundment. Therefore, an encapsulated disposal area able to contain 100 tons per day of brine during the operating discharge season and for the foreseeable future after closure would

need to be built near the Red Dog Mine site. The SEIS assumed the encapsulated brine disposal site would be located in a portion of the Main Pit. The Main Pit would have the capacity to hold more than 50 years of both precipitation sludge and brine. Therefore, an additional site would need to be built and managed to dispose of brine during long-term post-closure water treatment.

Reverse osmosis systems are in place at other mines and other industrial facilities, and are used on wastewaters with metals loadings comparable to the Red Dog Mine. While reverse osmosis may be technically feasible, the high TDS levels in the influent and the adverse climatic conditions present challenges for successful design and operation. In addition, large volumes of brine would need to be disposed and managed over the long-term.

Nanofiltration is a membrane process similar to reverse osmosis except the membrane has a higher particle size cutoff; up to 0.005 µm for nanofiltration compared to less than 0.002 µm for reverse osmosis. Typical pressures for nanofiltration applications range from 50 to 200 pounds per square inch. Nanofiltration removes bacteria, protozoa and some viruses from the water, as well as most natural organic matter and some natural minerals, especially divalent ions which cause hard water. Nanofiltration, however, does not remove dissolved compounds. Therefore, it is not considered a viable option for TDS treatment and was not evaluated in detail.

Electrodialysis is another membrane treatment technology where electricity is used as the driving force for separation instead of pressure. An electrical current is used to move the ions through a series of selective membranes. The consecutive membranes concentrate the ions in a wastestream and away from the treated water. Electrodialysis reversal is a modification of the process that switches charges during operation to promote cleaning. This technology is applicable for treatment of high TDS water because it is less susceptible to plugging and is easily cleaned. As discussed in more detail below, the downside to this process is the high energy use and the large volume of concentrated wastes requiring disposal (typically more volume than reverse osmosis). In addition, there are no examples of the use of electrodialysis at mining operations. Electrodialysis is therefore not considered a viable option for TDS treatment and was not evaluated in detail.

Ion Exchange

Ion exchange is a process where water flows through an ion exchange resin and undesirable ions in the water are exchanged for more benign ions on the resin. For this application, the ion exchange process would need to be a sequential process with strong acid cation resin to remove calcium followed by weak base anion resin to remove sulfate. The columns would be regenerated with sulfuric acid and caustic material, so the process would be removing TDS in exchange for water. Since there is no experience operating ion exchange systems of this type at the required volumes (15 MGD), and because of the large amount of sulfuric acid and caustic material required, ion exchange is not considered a viable option for TDS treatment and was not evaluated in detail.

Biological Treatment

Biological processes are used for sulfate removal in mine wastewaters by reducing sulfate to sulfide. The result is a change from calcium sulfate to calcium carbonate; however, both of these compounds contribute to TDS. Biological processes change the form of sulfur but do not provide for TDS removal and therefore are not considered viable for TDS treatment and were not evaluated in detail.

Barium Hydroxide

Barium hydroxide could be used with the existing water treatment to remove gypsum from the wastewater instead of or in combination with calcium hydroxide. Treatment of the entire discharge with barium hydroxide is expected to result in an end-of-pipe TDS levels around 1,500 mg/L. Enhanced treatment of a portion of the discharge is expected to reduce the annual average TDS concentration of the effluent from the current level of 4,120[1] mg/L to 3,000 mg/L. Sludge from the barium hydroxide process would be chemically stable and could be disposed of in the tailings impoundment during operations and in the Main Pit after closure for the reasonably foreseeable future.

Teck tested the use of enhanced barium hydroxide treatment during the summer and fall of the 2010 discharge season, during periods of low precipitation resulting in low stream flow in Red Dog Creek. Barium hydroxide was used during low stream flow events when stream capacity limited the discharge rate to less than 5,000 gallons per minute. The barium hydroxide treatment process was used from June 13 to June 30, July 18 to July 22, August 4 to August 13, and August 26 to September 8. The table below contains the TDS results of the weekly composite samples utilizing the barium hydroxide treatment process.

Date	TDS (mg/L)
6/14/2010	3230
6/21/2010	3000
6/28/2010	3120
7/20/2010	3260
8/9/2010	3020
8/30/2010	2950
9/8/2010	3300

Wastewater Pipeline

One of the alternatives analyzed in the Red Dog Aqqaluk SEIS entailed replacing the current discharge location in Red Dog Creek with a wastewater discharge pipeline transporting treated effluent from the mine site to the port site and discharging to the Chukchi Sea. The wastewater discharge pipeline was considered because it would allow Teck more flexibility in managing its wastewater.

As explained above, the purpose of this BPJ analysis is to determine a technology-based effluent limitation for TDS. In accordance with the Clean Water Act's national goal of eliminating the discharge of pollutants, identification of BAT and the resulting technology-based effluent limitations are meant to reduce the level of pollutants entering waters of the U.S. In this case, the wastewater discharge pipeline would not reduce the level of TDS entering waters of the U.S. Rather, it would only move the discharge from one water body to another, *i.e.*, from Red Dog Creek to the Chukchi Sea. Therefore, EPA has not identified the wastewater pipeline as an available technology for establishing technology-based effluent limitations, even though there may be other advantages to its use (as described in the SEIS).

[1] 2010 Final Supplemental Environmental Impact Statement.

OTHER ISSUES

In evaluating the treatment options described above, two stand out as potentially viable alternatives for treating the discharge at the Red Dog Mine to reduce TDS levels: reverse osmosis and the use of barium hydroxide. The following items were considered when making the final BPJ determination:

Reverse Osmosis. Based on the analysis in the SEIS, three 5-MW engines (only two would be operational at any given time) would need to be added to the site's generating capacity to supply power for the reverse osmosis water treatment system. This results in potential impacts to air quality (from the engine emissions). In addition, the use of reverse osmosis would require disturbance of additional land beyond the current mine site in order to build the treatment plant and site the brine disposal facility. The required space is not available at the mill. The SEIS assumed that a new treatment facility could be constructed at the northeast edge of the impoundment. This would include a thermal evaporation system to consolidate reverse osmosis solids in the brine prior to disposal. The required area could vary greatly depending on the final design configuration. As explained above, the brine from the process would have to be specially handled and encapsulated separately from other wastewater to prevent re-entrainment of the solids already removed from the wastestream. The brine disposal site would require long-term maintenance, in addition to that already required for the treatment plant and tailings pond.

It is estimated that utilization of the reverse osmosis system described in the SEIS would have a capital cost of $70 - $100 million with an additional $3 - $6 million in annual operating costs.

Given the high cost, additional energy needs, and additional impacts (long-term brine disposal and management), EPA has determined that the reduction of TDS in the effluent does not warrant the establishment of BAT limits based on reverse osmosis treatment.

Barium Hydroxide. The current design of WTP-2 uses slaked lime. Teck used the lime slakers[2] to dissolve the solid barium hydroxide for the barium hydroxide test. Due to the low temperature of the water added to dissolve the barium hydroxide, only 3% to 4% by weight could be dissolved using the lime slakers. This limited the treatment capacity of the plant to approximately 5,000 gpm of discharge quality water. There is not a sufficient volume of fresh water (Bons Creek Reservoir) available to dissolve the quantity of barium hydroxide that would be required to operate the plant at the 15,000 gpm discharge rate required to maintain the site's water balance. To operate the water treatment plant at the required rates, a new dry bulk reagent handling system would need to be designed and installed. In theory, a bulk handling system could be designed to feed dry barium hydroxide into water treatment plant. However, it is unknown if the barium hydroxide could be delivered to the site in a free-flowing condition that would enable the product to be directly fed into the water treatment plant.

Assuming a free flowing reagent source could be secured, the theoretical design of a bulk dry handling system would be similar to a lime bulk handing system. Teck estimates that design and installation of the bulk handling system would cost approximately $30 million. This is a preliminary estimate as a significant amount of engineering work would be required to determine if a barium hydroxide bulk handling system is possible. The shipping of the barium hydroxide to site would require approximately 1,700 shipping containers specially modified for direct feed into the bulk handling system. Assuming the modification required would be similar to the containers

[2] The mechanism in which quick lime is added to water to form a slurry.

used for the current ammonia nitrate bulk handling system, the cost of the containers would be approximately $10.2 million.

To estimate the cost of water treatment, a volume of 1.5 billion gallons was used. This is the approximate volume of water that would need to be treated in an average precipitation year to provide sufficient discharge volume to maintain the site-wide water balance.

Estimated Reagent Cost to treat 1.5 billion gallons of water				
	Reagent Demand (g/L)	Mass of Reagent Required (metric ton)	Cost per metric ton	Estimated annual reagent cost
Lime	0.94	5,337	$333	$1.8 m
Barium hydroxide	3.79	21,520	$1,185	$25.5 m

There would be additional costs associated with the movement of the additional 16,180 tonnes of reagent from the port to the mine that have not been included in the estimated cost. It is unclear if there is sufficient worldwide production capacity available to produce the 22 thousand tonnes of barium hydroxide that would be required annually. Teck experienced significant difficulty in securing the 3,800 tonnes of barium hydroxide that were used in a (nondischarge) test run in 2008 and for discharge during portions of the 2010 discharge season. At a minimum, the market would tighten and there would be a significant increase in the reagent's cost. However, it is likely that in the short term Teck would not be able to secure the required amount of barium hydroxide and in the long term it is unknown if there is a sufficient resource available – worldwide – to provide the amounts of reagent required for full-scale treatment.

Given the high cost, additional energy needs, and additional impacts (transport of the material from the port to the mine and the potential effect on the world-wide market), EPA has determined that the reduction of TDS in the effluent does not warrant the establishment of BAT limits based on treatment utilizing barium hydroxide.

BPJ LIMITATION DETERMINATION

EPA has considered the regulatory factors and determined that the BAT effluent limitation should be established based on the current treatment technology at the facility, described above. EPA calculated the TDS BAT limit based on procedures in Chapter 5 of the NPDES Permit Writers' Manual. The procedure calls for multiplying the long term average of effluent data by a daily variability factor, defined as the 99th percentile of the distribution of daily values divided by the mean. Using the data from Outfall 001 over the 5 year period 2006 – 2010 as shown in Attachment 1 (data for enhanced barium treatment was excluded from the calculation) and considering the long term average and the mean to be equal, the result is a maximum effluent value of 4925 mg/L. As discussed in the Statement of Basis, EPA has compared this effluent limitation with the water quality-based requirement of 1500 m/l at the edge of the mixing zone (Station 151) in Main Stem Red Dog Creek.

Since there is no assurance that a constant discharge of 4925 mg/L will meet the water quality based requirement of 1500 mg/L at Station 151 at all times, especially in low flow situations, EPA has concluded that the water quality-based requirement will result in a more stringent end-of-pipe discharge than application of BAT. The water quality-based requirements included in the draft permit are as follows:

> The permittee shall limit the TDS load discharged from Outfall 001 so as to maintain in-stream TDS concentrations at or below all of the following:

At the edge of the mixing zone (Station 151) in Main Stem Red Dog Creek: 1500 mg/L throughout the discharge season

ATTACHMENT 1

Sample Date	Reporting Result
5/11/2006	4,010
5/11/2006	4,090
5/11/2006	4,120
5/11/2006	4,240
5/15/2006	4,040
5/15/2006	4,150
5/15/2006	4,170
5/15/2006	4,190
5/15/2006	4,220
5/22/2006	3,130
5/22/2006	3,140
5/29/2006	2,330
6/5/2006	3,580
6/12/2006	3,340
6/19/2006	3,480
6/26/2006	3,750
7/4/2006	3,860
7/10/2006	3,560
7/17/2006	3,690
7/24/2006	3,740
8/1/2006	3,570
8/7/2006	3,680
8/14/2006	3,710
8/20/2006	3,800
8/27/2006	3,540
9/5/2006	4,050
9/10/2006	3,960
9/18/2006	3,880
9/24/2006	3,880
10/1/2006	4,110
5/26/2007	2,800
5/28/2007	2,740
6/4/2007	3,610
6/10/2007	4,020
6/10/2007	4,030
6/17/2007	4,000
6/25/2007	4,170
7/1/2007	4,220
7/9/2007	4,260
7/16/2007	3,660
7/24/2007	4,140
8/1/2007	4,110
8/6/2007	4,270
8/13/2007	4,040
8/20/2007	4,210
8/27/2007	4,150
9/4/2007	4,170
9/10/2007	4,050
9/16/2007	4,140
9/24/2007	4,120
10/1/2007	4,120
5/16/2008	4,220
5/19/2008	4,330
5/26/2008	4,410
6/2/2008	4,220
6/9/2008	3,570
6/15/2008	3,590
6/23/2008	3,740
7/1/2008	3,760
7/6/2008	3,840
7/14/2008	4,050
7/17/2008	4,130
7/22/2008	4,080
7/27/2008	3,980
8/4/2008	4,020
8/11/2008	4,180
8/18/2008	4,070
8/25/2008	4,410
9/5/2008	4,290
9/10/2008	4,310
9/14/2008	4,400
9/22/2008	4,330
5/8/2009	4,600
5/13/2009	4,270
5/18/2009	4,530
5/25/2009	4,390
6/2/2009	4,260
6/8/2009	4,030
6/15/2009	4,530
6/22/2009	4,420
7/2/2009	4,280
7/7/2009	4,430
7/13/2009	4,420
7/20/2009	4,560
8/4/2009	4,400
8/10/2009	4,800
8/22/2009	4,330
8/24/2009	4,620
9/1/2009	4,220
9/7/2009	4,480
9/14/2009	4,700
9/21/2009	4,670
5/8/2010	4,930
5/11/2010	5,070
5/17/2010	4,710
5/24/2010	4,590
6/1/2010	4,350
6/8/2010	4,360
6/14/2010	3,230
6/21/2010	3,000
6/28/2010	3,120
7/17/2010	4,300
7/20/2010	3,260
7/26/2010	4,280
8/3/2010	4,570
8/9/2010	3,020
8/18/2010	4,400
8/23/2010	4,410
8/30/2010	2,950
9/8/2010	3,300
9/13/2010	4,400
9/20/2010	4,360

Max	5,070
Min	2,330
Mean	4,092
Std Dev	435.7
CV	0.11
99 %tile	4924.8

Data collected during enhanced barium treatment.

STATE OF ALASKA
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
CERTIFICATE OF REASONABLE ASSURANCE

A Certificate of Reasonable Assurance, as required by Section 401 of the Clean Water Act (CWA), has been requested by Teck Alaska Incorporated (Teck) for National Pollutant Discharge Elimination System (NPDES) Permit AK-003865-2 to discharge treated wastewater and storm water from Red Dog Mine.

Public notice of the application for this certification was conducted according to 18 Alaska Administrative Code (AAC) 15.140.

A Water Quality Certification is required because the activity is authorized by a U.S. Environmental Protection Agency (EPA) permit identified as NPDES Permit AK-003865-2 and discharges will result from the activity.

The department certified AK-003865-2 on December 15, 2009, and the permit became effective on March 1, 2010. On March 17, 2010, the permit limits for lead, selenium, total dissolved solids (TDS), weak acid dissociable (WAD) cyanide, and zinc were withdrawn, and they were replaced with the limits for those substances contained in the 1998 permit. With the exception of the withdrawn limits, the permit remained effective. This permit action merely reinstates the withdrawn permit limits for TDS and WAD cyanide, compares the daily maximum and monthly average limits in the 1998 and 2010 permits for lead, selenium, and zinc, and imposes the more restrictive limit. For lead, the resulting limits combine the daily maximum from the 2010 permit with the monthly average from the 1998 permit; as for selenium, the daily maximum came from the 1998 permit and the monthly average from the 2010 permit; and both zinc limits were carried forward from the 1998 permit. For the sake of continuity, this Certificate supersedes the department's December 15, 2009 version. It covers the 2010 NPDES Permit AK-003865-2 and replaced limits in their entirety.

This NPDES Permit certification covers wastewater disposal from the following discharges:

1. Outfall 001 – discharge of treated wastewater and excess precipitation to the Lower Middle Fork of Red Dog Creek (Lower Middle Fork) located at latitude 68^{o} 04'17" N and longitude 162^{o} 52' 05" W and

2. Discharge of snowmelt and rainfall runoff from the site as indicated in the Stormwater Pollution Prevention Plan.

Under 18 AAC 70.235(b), the most recent EPA-approved regulation for Alaska site-specific criteria (SSC), the cadmium natural condition-based site-specific criterion (NCBSSC) in the Main Stem and Ikalukrok Creek, is 2.0 micrograms per liter (µg/L) derived from total recoverable metal concentrations. This value is representative of the natural condition and will protect all designated and existing uses.

The department reviewed the application, 2010 NPDES Permit, and this certification with respect to the water quality standard (WQS) antidegradation policy and finds the reduction in water quality to be in compliance with the requirements of 18 AAC 70.015, provided that the terms and conditions of this certification are made part of the final NPDES Permit. See Appendix A for the antidegradation analysis of decisions contained in this certification.
This Section 401 Certification applies to the 2010 NPDES Permit AK-003865-2. The department reviewed the discharges with respect to the Alaska Costal Management Program (ACMP) under 11 AAC 110. In a letter dated June 16, 2005, the ACMP stated that this version of NPDES Permit AK-003865-2 does not

require a consistency review, because this is a continuation of an ongoing project and proposes no modifications to effluent concentrations or volumes when compared to the previous, ACMP-consistent permit. Therefore, pursuant to 11 AAC 110.820(k)(4) and11 AAC 110.830, consistency review is not required for this permit reissue.

Having reviewed the permit, the department certifies that there is reasonable assurance that the proposed activity and any resulting discharge complies with the requirements of CWA Section 401, which includes WQS (18 AAC 70). Through this certification, in accordance with 18 AAC 15.120, ADOPTION OF NPDES PERMITS, the NPDES Permit will constitute the permit required under Alaska Statutes (AS) 46.03.100 Waste Disposal Permit, provided that the terms and conditions of this certification are made part of the final NPDES Permit. The department is specifying the following permit terms and conditions under authority of AS 46.03.110(d).

1. This certification authorizes the following three mixing zones (NPDES Permit parts I.A.1, I.A.7a, and I.C.1), which have been numbered for the sake of reference.

   First, mixing zone 1 in the Lower Middle Fork extends from Outfall 001 downstream to the confluence with the North Fork of Red Dog Creek (North Fork). The Lower Middle Fork mixing zone is approximately 7,000 feet long, authorized for pH, and shall be monitored at Station 151.

   Second, mixing zone 2 in the Main Stem of Red Dog Creek (Main Stem) extends from the confluence of the Lower Middle Fork with the North Fork to Station 151. The Main Stem mixing zone is approximately 1,930 feet long and provides mixing in the ratio of 1.5 parts receiving flow to 1 part effluent inflow for a dilution multiplier of 2.5. This mixing zone is authorized for the following parameters: TDS, ammonia, and cyanide measured as WAD cyanide.

   Third, mixing zone 3 in Ikalukrok Creek extends downstream from the confluence of the Main Stem and Ikalukrok Creek to Station 150. The mixing zone is approximately 3,420 feet long and provides mixing in the ratio of 1 part receiving flow to1 part Main Stem inflow for a dilution multiplier of 2. The Ikalukrok Creek mixing zone is authorized for TDS.

   See the map and schematic diagram in Attachments A and B, respectively.

Rationale: In accordance with State Regulations 18 AAC 70.240 to 18 AAC 70.270 (June 26, 2003), which are the most recent mixing zone regulations approved by EPA for issuance and certification of NPDES Permits, the department has authority to authorize mixing zones in permits or certifications.

a) 18 AAC 70.240(a)(1). The applicable requirements of 18 AAC 70 will be met.

The proposed mixing zones meet the requirements of the State water quality regulations at 18 AAC 70. In addition, the requirements of 18 AAC 70 will be met at all points outside of the mixing zones.

b) 18 AAC 70.245(a). Existing uses of the waterbody outside the mixing zone will be maintained and fully protected, such that existing uses outside the mixing zone are neither partially nor completely eliminated, and the overall biological integrity of the waterbody is not impaired.

In considering whether the mixing zones should be authorized, the department determined that existing uses of the receiving waters will be maintained and fully protected.

The department's review of effluent monitoring data and studies conducted by the Alaska Department of Fish and Game (ADF&G) indicate that existing uses will be maintained and fully protected in areas outside the mixing zones, including in the Main Stem, North Fork, and Ikalukrok Creek.

In the case of TDS, the discharge concentrations have been authorized by the department under Compliance Orders by Consent (COBCs) for nearly a decade. During this time, discharge water quality and biological impacts have been extensively monitored and analyzed by the department, ADF&G, and EPA. Under the 2003 permit modification, TDS limits at the boundary of mixing zone 2 were 1,500 milligrams per liter (mg/L) during Arctic grayling non-spawning and 500 mg/L during grayling spawning periods and 1,000 mg/L at the boundary of mixing zone 3. During non-spawning periods, there has been only one instance when water quality within mixing zone 2 did not comply with the limits contained in the 2003 permit modification. Water quality within mixing zone 3 has never deviated from limits contained in the 2003 permit modification. Upon appeal of the 2003 permit modification, the 500 mg/L limit for grayling spawning was remanded to EPA by the Environmental Appeals Board (EAB) for further consideration. Subsequent to the 2004 EAB decision, the department developed, and EPA approved, a revised SSC for the Main Stem, which established a TDS WQS of 1,500 mg/L for both spawning and non-spawning periods. The department determined that these levels would fully protect designated and existing uses of the waterbody, as summarized in the department's January 27, 2006 decision document supporting the TDS SSC.

Aquatic monitoring has shown fish populations in Red Dog Creek increase and decrease with time. There are, however, no discernible differences between populations in areas exposed to discharges from mine operations and in the North Fork, which is not exposed to mining operations. There also have been no effects on fish populations in the North Fork compared to pre-mining conditions indicating that there have not been adverse impacts on fish passage through the watershed. Last, there have been no observable negative impacts on existing uses, within the mixing zones or outside of them, since mining began. Over a decade of State of Alaska biological monitoring reports[3] indicate that discharges of TDS have not impaired existing uses, either within or outside the mixing zones, and there will be no impairment to the overall biological integrity of the waterbody.

For ammonia, there was no effluent limit in the 1998 permit. The actual discharge of ammonia is expected to be consistent with, or less than, historical levels and will not contribute to any impairment of existing uses. Based on analysis of discharge data, concentrations of ammonia in the mixing zone are expected to be significantly below the acute WQS, such that chronic levels of ammonia would rarely occur in the mixing zone between the North Fork and Station 151. For these reasons, the department has determined that the water quality associated with the ammonia limit will be adequate to fully protect existing uses.

For cyanide, the permit imposes a new limit based on weak acid dissociable (WAD) cyanide. The actual discharge of cyanide is expected to be consistent with historical levels and will not contribute to any impairment of existing uses. Discharge data indicates that the median value of WAD cyanide concentration in the effluent is well below chronic levels. Considering dilution, chronic levels of cyanide are not anticipated to occur in the mixing zone between the North Fork and Station 151. Additionally, the maximum projected concentration for WAD cyanide at the point of discharge is below the acute WQS. Concentrations of WAD cyanide in the mixing zone are expected to be significantly below the acute and chronic WQS. For these reasons, the department has determined that the water quality associated with the WAD cyanide limit will be adequate to fully protect existing uses.

The mixing zone for pH extends from Outfall 001 to the confluence of the North Fork. pH will be fully protective of the limited existing uses within the mixing zone and of existing uses at all points beyond. Based on water quality monitoring data, the baseline pH at the station just above Outfall 001 ranges from 5.8 to 6.7. An optimum wastewater treatment pH, approximately 9.5 to 10.5, precipitates metals from treated water before it is discharged through Outfall 001. Data collected in the discharge and in the

[3] See State's biological monitoring reports as cited in References section below.

receiving waters since mine operations began, indicate that pH stabilizes shortly after the discharge into Red Dog Creek. The pH is above 6.5 at Station 20 (upstream of the North Fork confluence) and is approximately 7 at the mouth of the Main Stem; i.e., the mixing of basic discharge waters with naturally acidic creek waters results in near neutral pH where fish occur, ensuring protection of existing uses within the mixing zones and at all points beyond. Beyond the mixing zone, pH standard of 6.5- 8.5 applies to protect aquatic life. Past sampling indicates that pH will be within this range at all points downstream of the mixing zone.

Additionally, under 18 AAC 70.230(e), the Lower Middle Fork has the designated uses of contact recreation (wading only), industrial purposes, and secondary recreation (except fishing). As a result, the most restrictive pH standard that would otherwise apply in the absence of the mixing zone is 6.5 to 8.5, which are the criteria for contact recreation. Contact use of the Lower Middle Fork consists of mine and agency personnel conducting instream sampling or other necessary instream work performed by the permittee. These uses, and use of the Lower Middle Fork for industrial purposes and secondary recreation, will not be adversely affected by the authorized mixing zone and, additionally, the pH mixing zone will not affect uses further downstream.

Based on this information, the department finds that existing uses outside of the mixing zones will be fully protected and maintained, and the mixing zones will not impair the overall biological integrity of the waterbody.

c) 18 AAC 70.240(a)(2). The mixing zones will be as small as practicable.

The department finds that the sizes of the mixing zones authorized for discharge in this certification are as small as practicable and consistent with the size limitations of 18 AAC 70.255(e)(3).

Under 18 AAC 70.255(e)(3), the length of a mixing zone established in a stream or other flowing fresh water may not extend downstream beyond the computed point where the variation in the concentration of a water quality parameter across a stream is predicted to be less than 5%, as determined using a standard river flow mixing model.

For mixing zone 1 (Outfall 001 to the North Fork), the size of the pH mixing zone, as discussed above, was based on extensive water quality sampling indicating that the basic, treated, mine wastewater mixes with the naturally acidic water of Red Dog Creek, reaching an overall pH of 6.5 to 7 by the confluence with the North Fork. Based on protection of the designated downstream uses, the department determined that the mixing zone is the smallest practicable size to ensure adequate mixing.

For mixing zone 2 from the confluence of the North Fork to Station 151, the size of the mixing zone was based on the smallest size to ensure adequate mixing. Flow and concentrations have been extensively monitored in Red Dog Creek. No significant dilution is achieved by contributions from side streams or sheetflow from upland sources or seeps. Conductivity is a field parameter that provides real time measurements of water composition, which were used to determine the point of complete mixing in the Main Stem. Transects of conductivity readings on multiple sampling dates were used to determine the length of the mixing zone. The point of complete mixing was determined to be where conductivity readings reached a stable value across the width of the channel. This method of determining complete mixing, based on measuring stable conductivity, is more accurate than mixing models often used by the department. For mixing zone 2, complete mixing occurs near a whirlpool feature, so stream geomorphology appears to control complete mixing. The department determined that this mixing zone, approximately 1,930 feet long, is the smallest practicable size to ensure adequate mixing.

For mixing zone 3 from Ikalukrok Creek to Station 150, the same approach was undertaken as for mixing zone 2. Complete mixing occurs near a whirlpool feature where a change in the river bank causes turbulence. The department determined that mixing zone 3, approximately 3,420 feet long, is the smallest practicable size to provide adequate mixing.

d) The maximum pollutant discharge limitations were calculated in compliance with 18 AAC 70.255(f).

18 AAC 70.255(f) governs calculation of the maximum pollutant discharge limitations in the context of establishing mixing zones. It allows the dilution calculations to be based on either actual flow data collected concurrent with the discharge or the low flow of the receiving water location.

In this case, the permittee requested mixing zones for ammonia and cyanide based on actual data comparing the ratio of the average daily flows at Station 10 in the Main Stem and the outfall from the tailings impoundment. The calculated dilution multiplier of 2.5 represents the 5th percentile of the ratios for the period from May 2003 through September 2005. Therefore, the dilution multiplier of 2.5 was used in calculating the maximum pollutant discharge limitations when authorizing the mixing zones.

For pH, data collected in the discharge and in the receiving waters since mine operations began indicate that pH stabilizes shortly after the discharge into Red Dog Creek. The pH is above 6.5 at Station 20 (upstream of the North Fork confluence) and is approximately 7 at the mouth of the Main Stem. Mixing of basic discharge waters with naturally acidic creek waters results in near neutral pH by the boundary of the mixing zone.

e) 18 AAC 70.240(a)(3). The effluent will be treated to remove, reduce, and disperse pollutants using methods found by the department to be the most effective and technologically and economically feasible, consistent with the highest statutory and regulatory treatment requirements.

The mine wastewater treatment plant treats water from the tailings impoundment and discharges to the Lower Middle Fork via Outfall 001 during the summer months, typically late May to early October. Metals, including lead, selenium and zinc, are removed using high density sludge (HDS) treatment process. For cadmium removal, sodium sulfide is added to the untreated feed water boosting the removal of this metal to levels below permit limits.

The HDS treatment process uses lime precipitation to treat for metals with their precipitation occurring in tanks equipped with agitators. Flocculent is then added and the precipitated solids are separated from the treated water in a clarifier. Clarifier underflow, containing the metals solids, is recycled back to the process inlet and is ultimately returned to the tailings impoundment while the clarifier overflow passes through sand filters before being discharged to Red Dog Creek. This process replaces the dissolved metals ions with calcium ions in the wastewater and results in a modest, up to ten percent, reduction of TDS concentration. However, TDS composition changes from sulfates of various metals to primarily calcium sulfate (gypsum).

Water treatment methods (distillation, membrane filtration, etc.) to significantly reduce TDS concentrations are not practicable or economic for the nature and volume of the effluent from the mine. The most effective and reasonable method for reduction of TDS in the mine's effluent is source control. The mine has implemented a TDS source control program to reduce the amount of TDS contained in the tailings pond water (the wastewater influent source). Source control measures include operation of a third water treatment plant to treat high TDS influent wastewater prior to entering the tailings pond and testing of waste rock and use of waste rock management practices to reduce the amount of TDS entering the tailings pond from waste rock runoff. Another source control measure currently being implemented includes the oxide-stockpile reclamation project, which will reduce acid rock drainage to the tailings pond.

This project was initiated in 2008 and construction of the cover is complete and monitoring of cover-performance is ongoing. Additionally, the proposed permit requires Teck to develop a TDS Management Plan (Section 1.A.7.f), which must be approved by EPA and the department providing information on actions Teck will take to enhance treatment and source control.

For cyanide, this pollutant is used in the lead extraction process as a pyrite (iron) depressant. The mine has investigated alternatives to the use of cyanide in the mill with unacceptable results. Small concentrations of WAD cyanide found in the effluent, less than 15 µg/L, are at levels that are not considered to be treatable with available water treatment technology. Unlike elemental pollutants, such as metals, cyanide is molecular and naturally attenuates in the tailings pond through oxidation. From August 1998 through September 2005, 97 WAD cyanide analyses were conducted on samples collected at Station 10. All 97 samples were reported at levels below the minimum level of quantification (ML) for the WAD cyanide analytical method, and 74 of the samples were reported as less than the method detection limit (MDL) for the WAD cyanide analytical method. Identical results have been documented in Ikalukrok Creek and the Wulik River. A combined 217 samples have been collected and analyzed by the WAD cyanide method at Stations 150, 160, and 2 since August 1998. Results from all samples were reported at levels below the minimum level of quantification (ML), and 189 of the samples were reported as less than the method detection limit (MDL) (EPA, 2006).

In addition, from August 2003 through October 2008, 64 WAD cyanide analyses were conducted on samples collected at Station 151 (located at the downstream boundary of the Main Stem mixing zone). Station 151 is upstream of Station 10 and provides a more conservative representation of WAD cyanide concentrations in the Main Stem, as Station 151 is less subject to influence by ambient runoff contribution (and resulting dilution) than is downstream Station 10. Again, all 64 Station 151 samples were reported at levels below the ML for the WAD cyanide analytical method, and 53 of the samples were reported as less than the MDL for the WAD cyanide analytical method.

As demonstrated by the monitoring results described above, the department finds that the treatment for WAD cyanide that occurs in the tailings pond is effective and reasonable for the concentrations present.

For ammonia, traditional water treatment methods for reducing the concentration in effluent (air stripping, biological treatment, chlorination, etc.) are not practicable at the mine, given the volumes and concentrations present. Source control is the most effective and reasonable method for reducing ammonia concentrations in the effluent. The primary source of ammonia in the effluent results from blasting with an ammonium nitrate and fuel oil mixture in wet blast holes in the mine pit. When placed in wet holes the ammonium nitrate dissolves into the groundwater in the vicinity of the blast hole. Mine drainage water, including the groundwater encountered in blast holes, is collected in the mine drainage sump, which is then pumped into the tailings pond. Since 1999 the mine has implemented the use of an emulsified blasting agent that results in minimal ammonium nitrate dissolving into the groundwater and subsequently entering the mine drainage sump. This source control technique has resulted in decreasing effluent ammonia concentrations since 1999. Condition 5 of this Section 401 Certification contains a specific best management practice (BMP) requirement carried forward to Section I.H.2.i.(vi) of the permit requiring the permittee to develop a BMP to ensure that best blasting practices are used in any wet blast holes to minimize the amount of blasting agent that dissolves in the groundwater in the vicinity of the blast hole.

After review of the applicable statutory and regulatory requirements, including 18 AAC 70 and 18 AAC 72, the department finds that the treatment measures used by the discharger to remove, reduce, and disperse pollutants represent the most effective, technologically and economically feasible techniques for controlling the quality of the mine effluent, and that these treatment measures meet the highest applicable statutory and regulatory requirements.

2. The department authorizes the effluent limits and monitoring requirements contained in the NPDES Permit Part I.A.1 – Table 1.

Rationale: In accordance with State Regulations, 18 AAC 15.090, the department may attach terms and conditions to a permit, variance, or approval, including operating, monitoring, inspection, sampling, access to records, reporting requirements, and the posting of a performance bond or other surety, that it considers necessary to ensure all applicable criteria will be met. The effluent limits included in the permit provide assurance that WQS are being met.

3. NPDES Permit part I.A.7.a shall maintain the following language:

After the commencement of discharge, the permittee shall limit the TDS load discharged from Outfall 001 so as to maintain in-stream TDS concentrations at or below:

(1) 1500 mg/L at the boundary of the mixing zone in the Main Stem of Red Dog Creek,

(2) 1000 mg/L at the boundary of the mixing zone in Ikalukrok Creek throughout the discharge season, and

(3) 500 mg/L from July 25th through the end of the discharge season at Station 160.

Rationale: The TDS SSC allows TDS concentrations up to 1500 mg/L in the Main Stem without timing restrictions. The department finds that the in-stream TDS limits are required to ensure that existing uses are protected.

Rationale: In 1999, the department changed the WQS under 18 AAC 70.020(b)(Note 12) for inorganic dissolved solids, regulated as TDS. This criterion is in effect in Ikalukrok Creek for the areas listed above:

> *Total Dissolved Solids (TDS) in concentrations up to 1000 mg/L in Ikalukrok Creek are in effect from the confluence of Ikalukrok Creek with the Main Stem to the Wulik River,* ***except*** *during chum salmon and/or Dolly Varden spawning in Ikalukrok Creek, when the aquatic life criterion of 500 mg/L will apply at Station 160.*

Rationale: In accordance with 18 AAC 70.020(b)(4) and Note 12, the TDS concentration at Station 160 shall remain at or below 500 mg/L from July 25th through the end of the discharge season to ensure no adverse effect.

In accordance with State Regulations 18 AAC 15.090, the department may attach terms and conditions to a permit, variance, or approval, including operating, monitoring, inspection, sampling, access to records and reporting requirements, and the posting of a performance bond or other surety, that it considers necessary to ensure that all applicable criteria will be met.

4. Permit part I.E – Bioassessment Program Requirements could be removed from the NPDES Permit. The bioassessment program in Red Dog Creek is part of a larger monitoring program that requires aquatic and biological monitoring in Red Dog Creek and Bons Creek drainages. To keep that larger program consistent and intact, the Bioassessment Program Requirements have been incorporated into the department's Waste Management Permit, and duplication here could lead to future inconsistencies. Nonetheless, the following table could be inserted into the NPDES Permit.

Bioassessment Sites	
Sample Site	**Factors Measured**
North Fork	Periphyton (as chlorophyll-a concentrations) Aquatic invertebrates: taxonomic richness and abundance Fish presence and use
Main Stem	Periphyton (as chlorophyll-a concentrations) Aquatic invertebrates: taxonomic richness and abundance Fish presence and use
Ikalukrok Creek	Periphyton (as chlorophyll-a concentrations) Aquatic invertebrates: taxonomic richness and abundance Fish presence and use

Rationale: In accordance with State Regulations 18 AAC 70.240, the department has authority to ensure that existing uses of the waterbody outside the mixing zone are maintained and fully protected. The specified monitoring will provide evidence to the department that the effluent treatment and mixing zone sizes are adequate to protect all existing and designated uses in the receiving water. The entire biomonitoring program contained in the current NPDES Permit is also required in the Monitoring Plan under the Waste Management Permit issued by the department for the management of tailings, waste rock, and other wastes at the facility.

In accordance with State Regulations 18 AAC 15.090, the department may attach terms and conditions to a permit, variance, or approval, including operating, monitoring, inspection, sampling, access to records and reporting requirements, and the posting of a performance bond or other surety, that it considers necessary to ensure that all applicable criteria will be met.

In accordance with Federal Regulation 40 CFR 124.53(e)(3), the department shall include a statement of the extent to which each condition of the permit may be made less stringent without violating the requirements of State law. These statements are included above where it states that a change "could" be made in the final permit.

5. The NPDES Permit shall include the following permit part I.H.2.i.(vi):
   Ensure that best blasting practices are used in any wet blast holes to minimize the amount of blasting agent that dissolves into the groundwater in the vicinity of the blast hole.

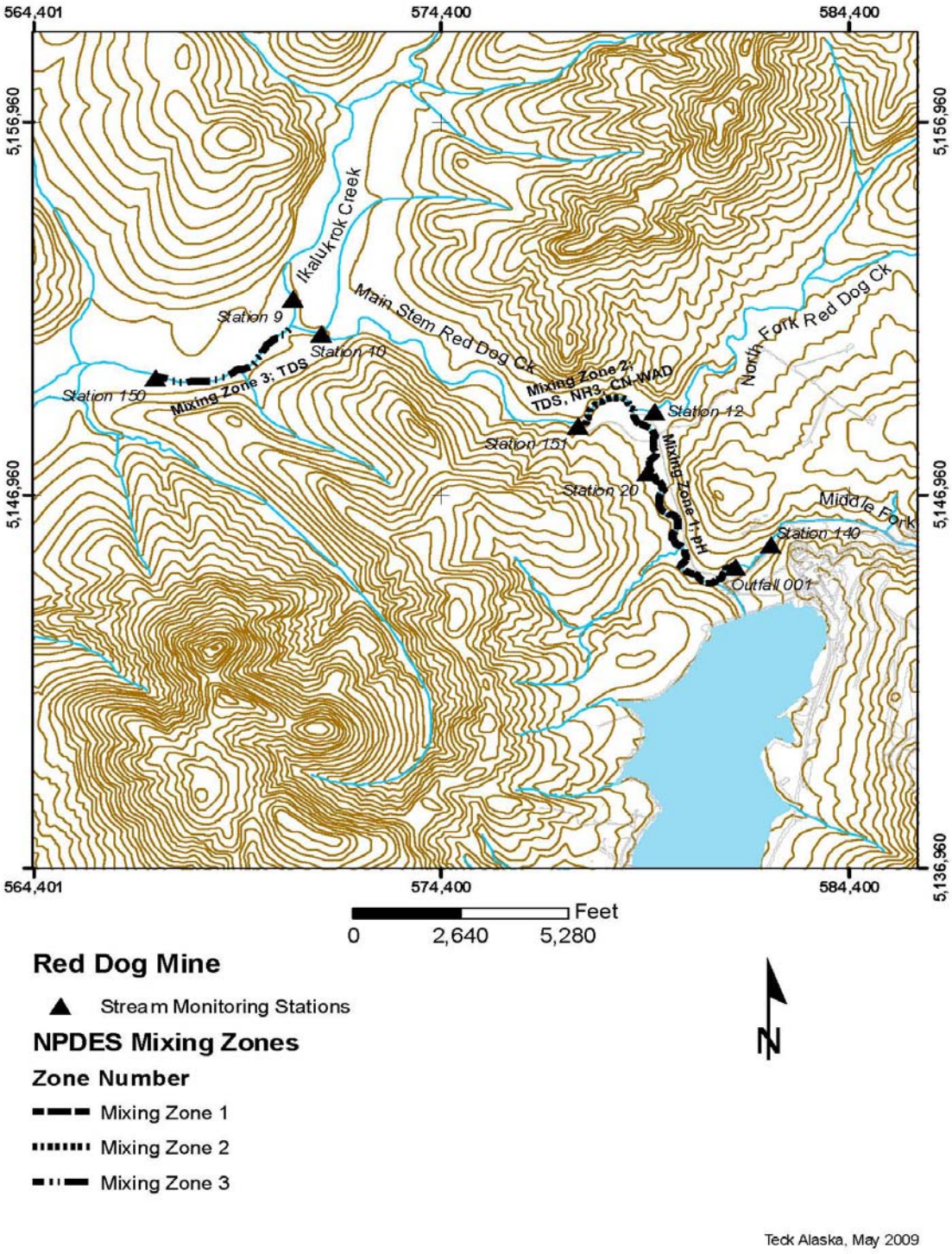
Rationale: In accordance with State Regulations, 18 AAC 15.090, the department may attach terms and conditions to a permit, variance, or approval, including operating, monitoring, inspection, sampling, access to records, reporting requirements, and the posting of a performance bond or other surety, that it considers necessary to ensure all applicable criteria will be met. The department considers this requirement necessary to ensure that appropriate source control measures are undertaken to minimize the amount of ammonia in the effluent.

April 15, 2011
Date

Sharon Morgan, Manager
Wastewater Discharge Authorization Program

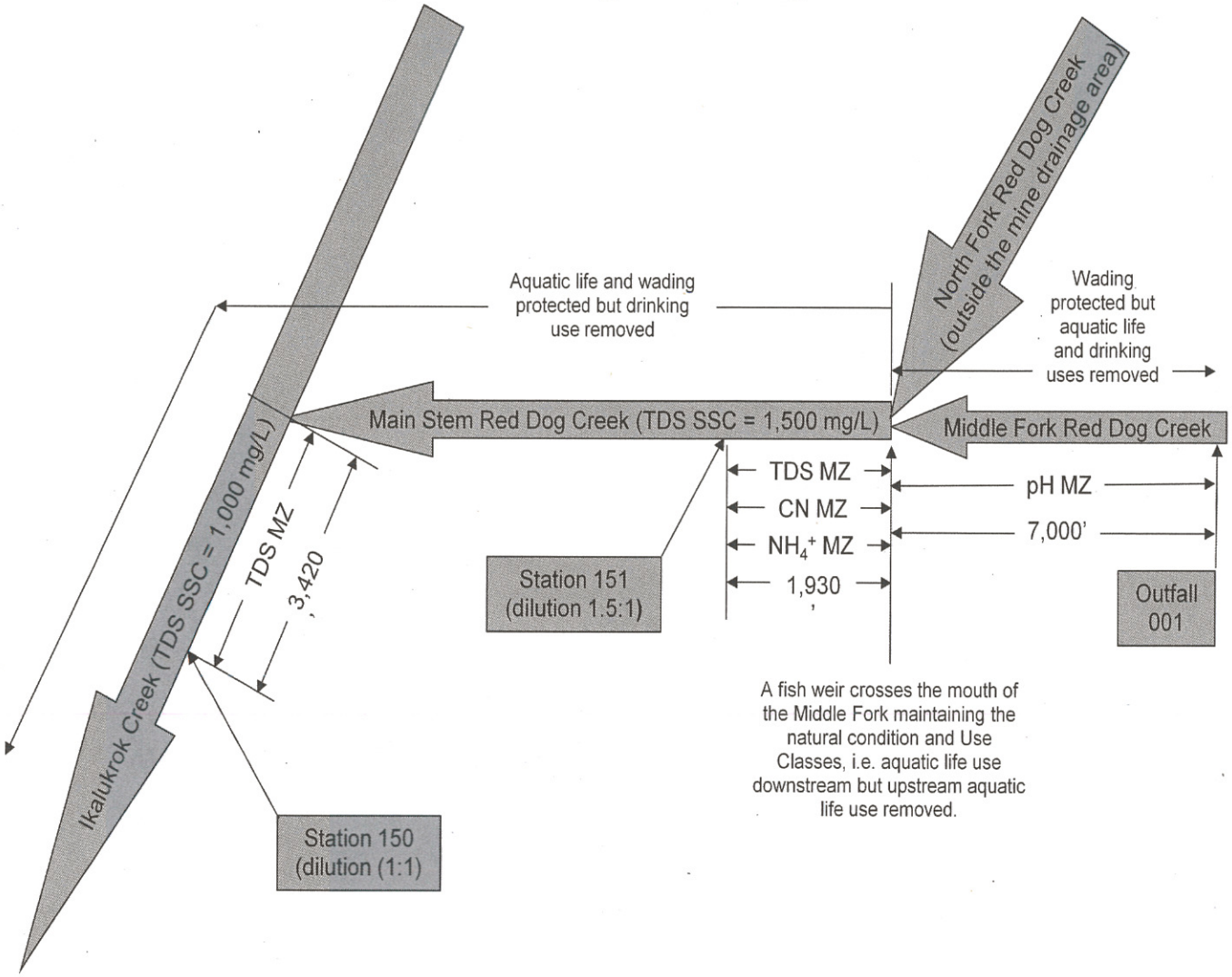
Attachment A

Red Dog Mine Mixing Zones



Attachment B

Diagram of Red Dog Mine Mixing Zones



APPENDIX A
ANTIDEGRADATION ANALYSIS OF THE CERTIFICATE OF REASONABLE ASSURANCE FOR NPDES PERMIT AK-003865-2

This appendix analyzes and provides rationale for the Alaska Department of Environmental Conservation (department) decisions in Section 401 Certification with respect to the antidegradation policy. The department's approach to implementing the antidegradation policy found in 18 AAC 70.015 is based on the requirements in 18 AAC 70 and the department's July 14, 2010, Policy and Procedure guidance for *Interim Antidegradation Implementation Methods* (antideg guidance). Using these requirements and policies, the department determines whether a waterbody or portion of a waterbody is classified as Tier 1, Tier 2, or Tier 3, where a larger number indicates a greater level of water quality protection. This determination was made on a pollutant-by-pollutant basis.

To qualify as a Tier 3, or "outstanding national resource" water, one of two criteria must be met. The water must either be 1) in a national or state park or wildlife refuge or 2) a waterbody with exceptional recreational or ecological significance. The department determined that the affected waters are not Tier 3 waters and conducted an antidegradation analysis assuming that the affected waters are Tier 2. The basis for this finding ensues.

The waters of Red Dog Creek are atypical of most undeveloped Arctic streams because of the high concentrations of cadmium, lead, and zinc that enter the Lower Middle Fork of Red Dog Creek (Lower Middle Fork) as it flows through a highly mineralized orebody. The unique character of the Red Dog mineralization and its interaction with ground and surface waters was recognized in scientific studies of the area in the late 1970s and early 1980s (e.g. Ward and Olson 1980). Natural levels of metals were known to be unusually high, and fish kills in the Main Stem of Red Dog Creek (Main Stem) were documented. From 1981 through 1984, Cominco Alaska funded a series of baseline studies to document water quality and biological conditions in Red Dog Creek, Ikalukrok Creek, and the Wulik River (Houghton 1983, Peterson and Nichols 1983). In 1982, the department funded a detailed toxicological, biophysical, and chemical assessment of Red Dog Creek (EVS Consultants, Ltd. 1983). These studies formed the basis for addressing aquatic and water quality impacts associated with the development of the Red Dog Mine Project in the 1984 Environmental Impact Statement.

Water in the Middle Fork of Red Dog Creek (Middle Fork), beginning adjacent to the highly mineralized orebody, was naturally degraded and remained in this condition downstream to the confluence with the South Fork of Red Dog Creek (South Fork) (Peterson and Nichols 1983). The Middle Fork flowed directly over heavily mineralized rock, and the creek received surface and groundwater draining from the orebody, which contained high metal and sulfide concentrations (U.S. Environmental Protection Agency and U.S. Department of the Interior. 1984). Recovery of water quality began at the confluence of the Middle Fork and the South Fork, but was not particularly significant until flow from the North Fork of Red Dog Creek (North Fork) diluted the Middle Fork to form the Main Stem.

As discussed above, Red Dog and Ikalukrok Creeks have been documented to have naturally occurring water quality conditions that precluded some designated uses, which have been removed (see 18 AAC 70.230(e)(8) and (18-20)). Specifically, the Lower Middle Fork is only classified for contact recreation (wading only), industrial, and secondary recreation (except fishing) uses. According to antideg guidance, this segment is considered a Tier 1 waterbody; therefore, protection of existing uses is the threshold for compliance with Alaska's antidegradation policy. All of the requirements in the permit will ensure protection of these uses. This includes the mixing zone for pH, which will not affect either the instream levels or the designated and existing recreational and contact uses of the segment. In practice but not policy, actual contact uses of the Lower Middle Fork are exclusively confined to hydrologic, water quality,

biological, and geologic sampling by mine and agency personnel, and these uses of the Lower Middle Fork will not be impacted by the elevated pH in the immediate vicinity of the discharge.

The Main Stem is classified for growth and propagation of fish, shellfish, and other aquatic life. Aquatic biomonitoring at the Red Dog Mine began in 1990 and has continued annually since then. As noted above, monitoring conducted prior to mining activities showed water quality and aquatic life impacts extending into the Main Stem. Aquatic biomonitoring and ambient water quality monitoring conducted during mine operations demonstrates that the effluent from the facility does not harm existing aquatic life in the Main Stem or Ikalukrok Creek. These results are summarized in the Comparison of Mainstem Red Dog Creek Pre-Mining and Current Conditions (Scannell, 2005) and the Final Supplemental Environmental Impact Statement (FSEIS) associated with the 2010 National Pollutant Discharge Elimination System (NPDES) Permit reissuance.

Conservatively, the department assumes that the Main Stem and Ikalukrok Creek are Tier 2 waterbodies. According to the antideg guidance, this antidegradation analysis considers changes made in the 2010 permit and reinstated permit limits that relax comparable effluent limits included in the 1998 permit, as described below. The permit includes equally stringent or more stringent limits for cadmium, copper, lead, pH, selenium, and zinc than the 1998 permit. For these pollutants, the permit is more stringent than the previous permit, and no antidegradation analysis is required.

The specific changes made by this permit to effluent limits that are subject to antidegradation analysis include:

- For aluminum, the permit introduces new limits, where the 1998 permit lacked aluminum limits. The permit includes an average monthly effluent limit (AMEL) for aluminum concentration equal to 53 µg/L compared to the chronic Alaska Water Quality Standard (WQS) of 87 µg/L and a maximum daily effluent limit (MDEL) for aluminum concentration equal to 157 µg/L compared to the acute WQS of 750 µg/L. An antidegradation analysis is undertaken later in this appendix for the new aluminum limits.

- For nickel, the permit introduces new limits, where the 1998 permit lacked nickel limits. The permit includes an AMEL for nickel concentration equal to 80 µg/L compared to the chronic WQS of 117 µg/L and a MDEL for nickel concentration equal to 216.5 µg/L compared to the acute WQS of 1,053 µg/L. An antidegradation analysis is undertaken later in this appendix for the new nickel limits.

- For cyanide, the permit includes a less stringent AMEL, i.e. 10.3 versus 4.0 µg/L, and MDEL, i.e. 22.2 versus 9.0 µg/L, than the 1998 permit. Cyanide was previously measured as total cyanide, but the Alaska WQS is now measured as weak acid dissociable (WAD) cyanide. The department certifies that a mixing zone for WAD cyanide with a dilution ratio of 1.5 parts receiving flow to 1.0 part inflow, for a dilution multiplier of 2.5, protects water quality. An antidegradation analysis is undertaken later in this appendix for the new cyanide limits based on WAD cyanide.

- The permit includes new effluent limits for ammonia based on a mixing zone that provides a dilution ratio of 1.5 parts receiving flow to 1 part inflow for a dilution multiplier of 2.5. An antidegradation analysis is undertaken later in this appendix for the new ammonia limits.

- For total dissolved solids (TDS), the permit includes a less stringent limit than the 1998 permit limits of 170 milligrams per liter (mg/L) AMEL and 196 mg/L MDEL. The permit contains 3 limits for TDS: (i) 1,500 mg/L measured at station 151 in the Main Stem; (ii) 1,000 mg/L measured at station 150 in Ikalukrok Creek; and (iii) 500 mg/L at Station 160 in Ikalukrok Creek over 10

miles downstream of Station 150 from July 25th through the end of the discharge season. An antidegradation analysis is undertaken later in this appendix for the new TDS limits.

(i) The new instream limit of 1,500 mg/L is based on the SSC in the Main Stem from the North Fork confluence to the confluence with Ikalukrok Creek, which was adopted subsequent to the 1998 permit. The 1,500 mg/L SSC was adopted in 18 AAC 70.236(b)(5) and approved by U.S. Environmental Protection Agency (EPA) on July 16, 2003 for periods other than grayling spawning. The SSC was revised in 2006 and established a 1,500 mg/L limit for grayling spawning and non grayling spawning times in the Main Stem from the North Fork confluence to the confluence with Ikalukrok Creek. This revision was approved by EPA on April 21, 2006 and forms the basis for the TDS limit in the current permit.

(ii) The new Ikalukrok Creek instream limit of 1,000 mg/L is based on the 1999 revision to the State's water quality criterion under 18 AAC 70.020(b) for inorganic dissolved solids regulated as TDS.

(iii) The new Ikalukrok Creek instream limit of 500 mg/L is required during the period of chum salmon and/or Dolly Varden spawning to prevent any adverse effect on spawning activity.

For Tier 2 water in the context of reissuing a permit such as this, antidegradation analysis under 18 AAC 70.015(a)(2) is applied to permit limits that were relaxed or others which the department concludes should be subjected to antidegradation analysis. Under antideg guidance for Tier 2 waterbodies, the department's antidegradation analysis focuses on the following parameters based on the possibility for water quality degradation: aluminum, ammonia, cyanide, nickel, and TDS.

The Antidegradation Policy of the AWQS (18 AAC 70.015(a)(2)) states that, if the quality exceeds levels necessary to support propagation of fish, shellfish, and wildlife in and on the water, that quality shall be maintained and protected, unless the department makes five specific findings.

1. 18 AAC 70.015(a)(2)(A). Allowing lower water quality is necessary to accommodate important economic or social development in the area where the water is located.

Degradation of water quality associated with the permitted discharge of wastewater from Red Dog Mine is justified for the following reasons. First, even though wastewater discharge quality is considered degraded, wastewater discharge quality is elevated relative to the natural condition of historic water quality at the discharge point. Before mining, Red Dog Creek earned its name, in part, from its red color. The creek originated above the mineralized deposit bearing ore. As it flowed over the deposit, water became acidic and dissolved metals content climbed. Beyond the mineral deposit, acidity of creek water decreased, iron precipitated, and the stream turned red, hence Red Dog Creek. The natural condition of the creek water quality in the vicinity of the mine is very acidic with elevated concentrations of metals, and it was unable to support aquatic life. Permitted wastewater discharge quality may be considered degraded. However, water quality in Red Dog Creek has improved since mining began. This is demonstrated by fish colonizing parts of Red Dog Creek, which were uninhabitable to them before mining, and by water quality monitoring data indicating nearer neutral pH and lower metals content. Further, Red Dog Mine provided a $254 million financial surety for long term water treatment so that water quality will not revert to its original state after mine closure.

Second, permit limits ensure protection of water quality standards, provide for water quality adequate to protect existing and designated uses, and treat and control discharges by the most effective and reasonable means and to the highest statutory and regulatory requirements. The permit, fact sheet, and statement of

basis addressing withdrawn permit limits explain that limits for aluminum, ammonia, cyanide, nickel, and TDS are water quality-based and more stringent than any applicable technology-based standards.

Third, analyses performed in the FSEIS, Red Dog Mine Closure and Reclamation Plan, and Appendix A to EPA's statement of basis for reinstating withdrawn permit limits each conclude that there are no reasonable alternatives to the current water treatment system based on either economics or effectiveness.

On pages 3-324 through 3-326 of the FSEIS, EPA provides an analysis discussing direct and indirect socioeconomic impacts of Red Dog Mine on the Northwest Arctic Borough (NWAB), NANA, and the local work force. The FSEIS details large contributions by Red Dog Mine to the local economy's job market and revenue and tax bases. The following was excerpted from Section 3.17.4 of the FSEIS on which the State of Alaska Department of Natural Resources participated as a cooperating agency.

> The Red Dog Mine provides substantial benefit to the NWAB, NANA, and NANA shareholders by providing local employment opportunities, PILT (payments in lieu of taxes), royalties, and dividends. Alternative A would see the end of operations in 2011, 20 years sooner than the other alternatives. Closure in 2011 would result in the loss of $8 million annually in PILT to NWAB, and an estimated loss of $155 million in annual NANA royalties, $70 million in annual payments to the state, and over 500 jobs held by employees from inside and outside the region.

As noted above, the operation of Red Dog Mine is important to the economy of the NWAB. The department finds that authorization of the mine's discharge is justified, accommodates important economic activity in the NWAB, and that this requirement is met.

2. 18 AAC 70.015(a)(2)(B). Except as allowed under this subsection, reducing water quality will not violate the applicable criteria of 18 AAC 70.020, 18 AAC 70.235, or 18 AAC 70.030.

The permit limits will not violate water quality or applicable SSC. The mixing zones are specifically authorized in accordance with 18 AAC 70.240 to 18 AAC 70.270 (June 26, 2003). The authorized mixing zones have been sized to ensure that all applicable water quality criteria are met at all points outside of the mixing zone. There is no mixing zone for whole effluent toxicity and the limit is unchanged from the 1998 permit at 12.2 MDEL and 9.7 AMEL. The department finds that this requirement is met.

3. 18 AAC 70.015(a)(2)(C). The resulting water quality will be adequate to fully protect existing uses of the water.

The permit reissue application does not propose any changes that would likely result in wastewater of lower quality to be discharged than has been discharged since issuance of the 1998 permit. Although TDS levels have been relaxed in this permit compared to the limits in the 1998 permit, the mine has never been able to comply with the TDS limits from the 1998 permit and, consequently, has discharged under Compliance Orders by Consent (COBCs). The TDS limits established under the COBCs are identical to those established in the reissued permit. Therefore, an assessment of the impact of discharges on existing uses over the past 5-10 years[4] provides a reasonable means to evaluate the potential impacts on existing uses under the reissued permit.

Aquatic biomonitoring and ambient water quality monitoring conducted for about 20 years of mine operations demonstrates that the effluent from the facility does not negatively affect existing uses in the

[4] See State's biological monitoring reports as cited in References section below.

Main Stem, Ikalukrok Creek, or local tributaries such as the North Fork. As discussed below, the department finds that the resulting water quality will be adequate to fully protect existing uses.

For aluminum, new limits based on total recoverable concentration are established in the permit. The actual discharge of aluminum is expected to be consistent with historic levels and will not contribute to impairment of existing uses. Aluminum concentration discharge data with a median aluminum concentration of 11.5 µg/L indicate a large margin of compliance when compared to the AMEL of 53 µg/L. In turn, the AMEL equal to 53 µg/L offers a large margin of protection when compared to the chronic WQS of 87 µg/L. For these reasons, the department determined that the water quality associated with the aluminum limits will be adequate to fully protect existing uses.

For nickel, new limits based on total recoverable concentration are established in the permit. The actual discharge of nickel is expected to be consistent with historic levels and will not contribute to impairment of existing uses. Discharge data with a maximum nickel concentration of 51.9 µg/L indicate a large margin of compliance when compared to the AMEL of 80 µg/L. In turn, the AMEL equal to 80 µg/L offers a large margin of protection when compared to the chronic WQS of 117 µg/L. For these reasons, the department determined that the water quality associated with the nickel limits will be adequate to fully protect existing uses.

For cyanide, a new limit based on WAD cyanide is established in the permit. The actual discharge of cyanide is expected to be consistent with historical levels and will not contribute to any impairment of existing uses. Based on analysis of discharge data, the median value of cyanide at the point of discharge (outfall 001) is below chronic levels. Given the dilution that occurs, chronic levels of cyanide would rarely occur in the mixing zone between the North Fork and Station 151. Additionally, the maximum projected concentration for cyanide at the point of discharge is below the acute water quality standard. Concentrations of cyanide in the mixing zone are, therefore, expected to be significantly below the acute water quality standard. For these reasons, the department determined that the water quality associated with the WAD cyanide limit will be adequate to fully protect existing uses.

For ammonia, a new limit is established in the reissued permit. The actual discharge of ammonia is expected to be consistent with, or less than, historical levels and will not contribute to any impairment of existing uses. Based on analysis of discharge data, the median value of ammonia at the point of discharge (outfall 001) is below chronic levels. Given the dilution that occurs, chronic levels of ammonia would rarely occur in the mixing zone between the North Fork and Station 151. Concentrations of ammonia in the mixing zone are expected to be significantly below the acute water quality standard. For these reasons, the department has determined that the water quality associated with the ammonia limit will be adequate to fully protect existing uses.

For TDS, the reissued permit provides new limits of: (i) 1,500 mg/L at Station 151; (ii) 1,000 mg/L at Station 150; and (iii) 500 mg/L at Station 160 from July 25th through the end of annual discharge.

The mine has never been able to comply with the TDS limits imposed by the 1998 permit. As a result, the mine was subject to EPA COBCs from 1999 through 2006. The 2004 and 2005 EPA COBCs limited instream TDS concentration to 1,500 mg/L outside of grayling spawning season and 500 mg/L during grayling spawning. In 2006, the EPA COBC established TDS limits identical to those proposed in this reinstated permit. From 2007 through 2010, State-issued COBCs also established TDS limits that mirrored those of the 2006 EPA COBC as well as those proposed in this reinstated permit.

i) For the TDS limit of 1,500 mg/L at Station 151: During non-grayling spawning times, the department promulgated under 18 AAC 70.235 a site-specific criterion of 1,500 mg/L for TDS in the Main Stem from the confluence of the Middle Fork with the North Fork to the confluence

of the Main Stem with Ikalukrok Creek, except during Arctic grayling spawning in the Main Stem, This standard was extensively evaluated by EPA and the department and found to be protective of grayling and other existing and designated uses. Further information and support for the site-specific criterion for this waterbody is part of the department's file for that rule-making.

For periods during grayling spawning, the limit is based on the 2006 SSC for Red Dog Creek, which set water quality criterion at 1,500 mg/L at all times. The technical analyses by the department and EPA supporting the 2006 SSC indicate that the 1,500 mg/L TDS limit is sufficiently conservative to protect spawning grayling, as well as all other existing and designated uses. Results from toxicity tests undertaken in 2005 consistently demonstrated no effect on reproduction at TDS concentrations in excess of the maximum TDS concentrations tested (2,782 mg/L). In light of the extensive analysis of TDS and its potential impact on grayling and Dolly Varden spawning, the department has determined that the water quality associated with the 1,500 mg/L limit will be adequate to fully protect grayling spawning and other existing uses of the water, including use of the mixing zone as a migration corridor to reach the North Fork.

ii) For the TDS limit of 1,000 mg/L at Station 150: In 1999, the department changed the water quality criterion under 18 AAC 70.020(b) for inorganic dissolved solids, regulated as TDS, to the following: TDS may not exceed 1000 mg/L. A concentration of TDS may not be present in water if that concentration causes or reasonably could be expected to cause an adverse effect to aquatic life (see note 12).

Note 12: If a permit applicant proposes to raise the TDS levels in the receiving water to result in a concentration in the waterbody between 500 mg/L and 1,000 mg/L for all sources or above 110 mg/L for the potassium ion, the department will require a permit applicant to provide information that the department identifies as necessary to determine if the proposed TDS level will cause or can reasonably cause an adverse effect to aquatic life; based on its analysis, the department will limit the TDS level in the waterbody as necessary to prevent an adverse effect, and will set permit effluent limits accordingly; the burden of proof to demonstrate no adverse effect is on the permit applicant; implementation of the "no adverse effect" criterion is not subject to 18 AAC 70.235.

The department finds that the biomonitoring and other information submitted by Teck, and other pertinent information reviewed, demonstrate that a criterion of 1,000 mg/L will fully protect existing and designated uses.

iii) For the TDS limit of 500 mg/L at Station 160 from July 25th through the end of the discharge season: During the period of chum salmon and/or Dolly Varden spawning, the department finds that a lower TDS level of 500 mg/L is required, and that this limit will protect existing and designated uses, including spawning activity and the aquatic life generally. The evidence to support these findings include the support documentation for the SSC in department files, as provided to EPA, as well as the bio-monitoring data received from Alaska Department of Fish and Game, Habitat Division.

In summary, the conditions proposed in this permit reflect virtually the same conditions which have historically demonstrated that the effluent from the facility does not negatively affect existing uses in Red Dog Creek, Ikalukrok Creek, or their tributaries[5]. To illustrate, following is a summarized comparison of biological conditions in the Red Dog Creek drainage for pre-mining and current conditions (Weber Scannell 2005):

[5] See State's biological monitoring reports as cited in References section below.

- Before development of the Red Dog Mine, (a) water quality was naturally degraded in Red Dog Creek; (b) fish use was limited to migration to the North Fork during high water events; (c) no fish spawning was documented in Red Dog Creek; and (d) natural fish kills commonly occurred in Red Dog Creek.
- Development of the Red Dog Mine included a number of water management practices that resulted in improved water quality in Red Dog Creek. These practices included collection, treatment and discharge of mineralized water; discharge of high volumes of water with low metals concentrations; and improvements in water treatment.
- High volumes of treated water are discharged to Lower Middle Fork. This water dilutes the naturally occurring metals in Red Dog Creek, moderates the pH, and lessens the toxicity of metals by increasing the hardness.
- As a result of improved water quality, Arctic grayling began using Mainstem Red Dog Creek for spawning and rearing and Dolly Varden for rearing.
- Improved water quality was followed by development of abundant and diverse aquatic invertebrate and periphyton communities.
- Over the last six years (1998 through 2004) there is a viable aquatic community in Mainstem Red Dog Creek with the current water quality and mine discharge.

Biomonitoring in the Red Dog Creek drainage has continued from 2005 to 2009 and results of these studies indicate that the conclusions made by Weber Scannell in 2005 are still valid and appropriate. The department finds that this requirement is met.

4. 18 AAC 70.015(a)(2)(D). The methods of pollution prevention, control, and treatment found by the department to be most effective and reasonable will be applied to all wastes and other substances to be discharged.

The mine wastewater treatment uses a lime precipitation process to treat for metals in the wastewater. This process replaces the dissolved metal ions with calcium ions in the wastewater, and the nature of the TDS changes from primarily metal sulfates to calcium sulfates, thus reducing TDS concentration. Water treatment methods for further reducing TDS (distillation, membrane filtration, etc.) are not practicable for the nature and volume of the effluent from the mine. The most effective and reasonable method for reduction of TDS in the mine's effluent is source control. The mine has implemented a TDS source control program to reduce the amount of TDS contained in the tailings pond water (the wastewater influent source). Source control measures include operation of a third water treatment plant to treat high TDS influent wastewater prior to entering the tailings pond, waste rock testing, and application of waste rock management practices to reduce the amount of TDS entering the tailings pond from waste rock runoff.

Water treatment methods for reducing the ammonia concentrations (air stripping, biological treatment, chlorination, etc.) in the effluent are not practicable given the volumes and concentrations present. Source control is the most effective and reasonable method for reducing the ammonia concentrations in the effluent. The primary source of ammonia in the effluent results from blasting with an ammonium nitrate and fuel oil mixture in wet blast holes in the mine pit. When placed in wet holes the ammonium nitrate dissolves into the groundwater in the vicinity of the blast hole. Mine drainage water, including the groundwater encountered in blast holes, is collected in the mine drainage sump, which is then pumped into the tailings pond. Since 1999, the mine has implemented the use of an emulsified blasting agent that results in minimal ammonium nitrate dissolving into the groundwater and subsequently entering the mine drainage sump. This source control technique has resulted in decreasing effluent ammonia concentrations since 1999. Condition 5 of the Section 401 Certification contains a specific best management practice (BMP) requirement that is carried over to Section I.H.2.i.(vi) of the permit requiring development of a

BMP to ensure that best blasting practices are used in any wet blast holes to minimize the amount of blasting agent that dissolves in the groundwater in the vicinity of the blast hole.

Cyanide is used in the lead extraction process as a pyrite depressant. Teck has investigated alternatives to the use of cyanide in the mill with unacceptable results. WAD cyanide concentrations less than 15 µg/L found in the effluent are of such low levels that they are not considered to be treatable with available water treatment technology. Some degradation of cyanide occurs in the tailings pond through oxidation. The following passage summarizes WAD cyanide monitoring results over the course of a seven-year period.

> From August 1998 through September 2005, 97 WAD cyanide analyses were conducted on samples collected at Station 10. All 97 samples were reported at levels below the minimum level of quantification (ML) for the WAD cyanide analytical method and 74 of the samples were reported as less than the method detection limit (MDL) for the WAD cyanide analytical method. Identical results have been documented in Ikalukrok Creek and the Wulik River. A combined 217 samples have been collected and analyzed by the WAD cyanide method at Stations 150, 160, and 2 since August 1998. Results from all samples were reported at levels below the minimum level of quantification (ML) and 189 of the samples were reported as less than the method detection limit (MDL). (EPA, 2006)

As demonstrated by these monitoring results, the department finds that the amount of treatment for WAD cyanide that occurs in the tailings pond is effective and reasonable for the concentrations present. The department finds that this requirement is met.

5. 18 AAC 70.015(a)(2)(E). All wastes and other substances discharged will be treated and controlled to achieve (i) for new and existing point sources, the highest statutory and regulatory requirements; and (ii) for nonpoint sources, all cost-effective and reasonable best management practices.

After review of the applicable statutory and regulatory requirements, including 18 AAC 70 and 18 AAC 72, and consideration of the methods of pollution prevention, control, and treatment utilized at the Red Dog Mine, as discussed in detail above, the department finds that the discharges from the existing point source meet the highest applicable statutory and regulatory requirements and that nonpoint sources are fully addressed through cost-effective and reasonable BMPs. The department finds that this requirement is met.

Finally, the department reflected on whether to consider in its antidegradation analysis an alternative of conveying wastewater to a marine discharge at the port site. A pipeline alternative was examined in the recent FSEIS resulting from new development of the Aqqaluk deposit. A pipeline alternative was also included in an agreement to settle a citizen suit.

Project development typically involves an early planning phase, often conducted pursuant to the National Environmental Policy Act (NEPA), that involves generating and comparing conceptual project designs and selecting a preferred alternative based on environmental impacts and other factors. After NEPA findings are made, applications for environmental and other permits follow.

As a practical matter, there must be some limit to the sorts of potential alternatives that the department will consider when projects have evolved through the planning process and reach the permitting phase. On the surface, it is difficult to imagine that the department would compel an applicant, as part of the permit process, to wholly redesign the wastewater treatment and discharge arrangement to implement an alternative that was considered, but not selected during the earlier NEPA planning phase.

EPA's "Technology-based Best Professional Judgment Analysis" accompanying the permit reissuance concluded that EPA has not identified the pipeline as an available technology for establishing technology-

based effluent limitations. In the case of the settlement agreement, Teck agreed to 'diligently pursue' the concept of a pipeline.

For the reason cited by EPA, and for other reasons, the department concluded that it would not be reasonable to require the company to adopt a very different arrangement for discharge of treated wastewater and declined to conduct a detailed review of a pipeline alternative as part of its antidegradation analysis. Supporting this conclusion is that the wastewater infrastructure for the Red Dog Creek discharge point is largely extant and was constructed at considerable expense, that diverting the wastewater from Red Dog Creek would have immediate, direct and substantial adverse effects on the biota that now inhabit Red Dog Creek as a result of the diluting effect of the treated wastewater discharge, and that any pipeline alternative is highly speculative and would require not only overcoming significant wastewater permitting decisions surrounding a discharge to an entirely different waterbody (the Chukchi Sea), but also permitting decisions associated with construction of more than fifty miles of pipeline made by other jurisdictional state and federal agencies.

In the end, the department concluded that, for purposes of the antidegradation analysis, a pipeline would not be a reasonable alternative warranting further consideration at this time. In the event that the company chooses to advance a pipeline alternative through the NEPA and permit processes, the department will consider it more closely then.

References

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